

Energy efficiency in further and higher education –

Monitoring and targeting, University of Wales, Cardiff



- Energy cost savings of £63 000 a year
- Start-up costs recovered within six months
- CO₂ emissions reduced
- More effective targeting for energy-saving campaigns



ENERGY EFFICIENCY

INTRODUCTION

INTRODUCTION

Strict budgetary constraints are being felt throughout the further and higher education sector. Money saved through energy efficiency makes a useful contribution to financing core functions and improving facilities.

Energy cost savings of more than £60 000 a year are being generated by a monitoring and targeting (M&T) system at the University of Wales, Cardiff.

The M&T system enables the University to:

- assess the relative energy performance of its buildings
- ensure that benefits from energy efficiency investments are realised and sustained
- identify and counteract undue increases in energy consumption
- inform departments of their energy usage and costs.

It took the University just six months to recover the £25 000 cost of setting up the system.

MONITORING OF ENERGY USAGE

Over the last five years the University has invested £950 000 in energy efficiency measures, including high-efficiency lighting, automatic lighting controls, improvements to the building fabric, new boilerplant and a building energy management system (BEMS).

The priority given to energy efficiency by the University since 1991 is reflected in its position on the energy management matrix (see page 4).

Accurate recording of electricity usage



To secure the full value from its planned investment, the University knew that it needed a monitoring system that would provide accurate and reliable information on energy use. Historical energy consumption data based on invoices had proved inadequate because of irregular billing intervals and the frequent use of estimated readings. It was also difficult to assess the relative performance of buildings because in many cases groups of buildings were served by a single meter.

To overcome these problems the Estates Department divided the University into a number of areas called energy accounting centres (EACs). Extra sub-meters were installed to allow each EAC to be separately monitored and a system was set up for the manual reading of all meters every month.

Billed data from the utilities continued to be recorded for checking against in-house meter readings and for tariff analysis and fuel purchasing purposes.

METERING AND DATA COLLECTION METHODS

The University now has over 350 gas, electricity and water meters. An ex-utilities meter reader is employed for five days a month for speed and accuracy of data collection. Readings are written into a log book and then transferred into an analysis spreadsheet. The log book makes re-checking easy on the rare occasions that misreadings are suspected.

Monthly running costs for the system are estimated at £600, covering meter reading, data analysis and report production.

All new meters are fitted with a pulse output facility and around 25 are now automatically data logged by the University's BEMS. The on-line monitoring provides additional data that can be used to profile energy usage on a half-hourly basis. This allows more detailed investigations into energy usage, for example quantifying out-of-hours consumption. Meters are still read manually to provide consistent data for the overall M&T spreadsheet.

DATA ANALYSIS

An energy specialist from within the University was recruited to manage the setting up of the meter reading system and to formulate the method of analysing the data.

A standard spreadsheet package was used for storing and analysing the data. This provided the simplest means of apportioning consumption and reporting for each of the 72 EACs.

TARGETING

The spreadsheet calculates specific electricity and gas usage figures (kWh/m^2 and £/m^2) for each EAC together with its moving annual total (MAT) for each fuel. One month's MAT is calculated by adding its consumption figure to those for the previous 11 months. In this way the MAT always includes full data for 12 months. It provides an effective way of detecting, at an early stage, adverse trends in energy performance.

Specific energy consumption data enables the performance of similar buildings to be compared in terms of both energy consumption and cost. Adjustment factors for weather (degree-days) and hours of use are incorporated into the analysis. League tables are produced to rank the buildings in order of their specific consumption/cost and also the percentage change in their MAT. Savings for each cost centre are then calculated against a base year performance in 1992, and are put together to give total savings for the building stock.

Trials set up in January 1993 demonstrated the viability of the M&T procedures, with full implementation following in September. A bar chart of typical results logged by the M&T system is shown in figure 1.

TARGETING

Target energy consumption figures are set for all separately metered buildings. These targets were initially set in line with performance indicators

published by the Department of the Environment^[1]. As actual energy consumption data was accrued each building's target was refined to reflect a more realistic potential.

Targets may be further adjusted in the light of standards published in June 1996 by the Higher Education Funding Council^[2]. These will provide a series of targets for electricity and gas usage for a range of designated building types and functions.

IDENTIFYING HIGH ENERGY USE BUILDINGS

Buildings showing the worst energy performance were selected for more detailed investigation. While some of the larger, more efficient buildings have annual energy costs of only £9/m^2 of floor area, others have been as high as £22/m^2 .

Installing sub-meters has proved valuable. Before sub-metering, it was known that the Library and the two other buildings served by the same electricity meter had an average annual consumption of 85 kWh/m^2 which, while not particularly good, gave no cause for concern. When the buildings were metered separately, as shown in figure 1, it was found that the Library was the prime user with excessive consumption of 140 kWh/m^2 caused by air-conditioning and heavy use of IT equipment. In contrast, the other buildings were each performing well at around 50 kWh/m^2 and resources were thus concentrated on improving the performance of the Library.

Before sub-metering	
Total average performance for 3 buildings	
After sub-metering	
Individual performance of buildings	
Labs	
Lecturing/catering	
Library	

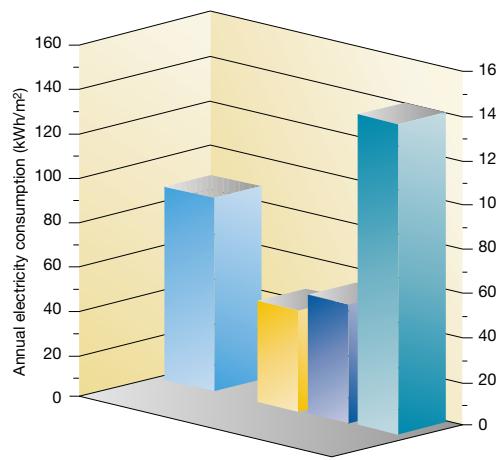


Figure 1 Disaggregation of performance by sub-metering used to highlight high energy users

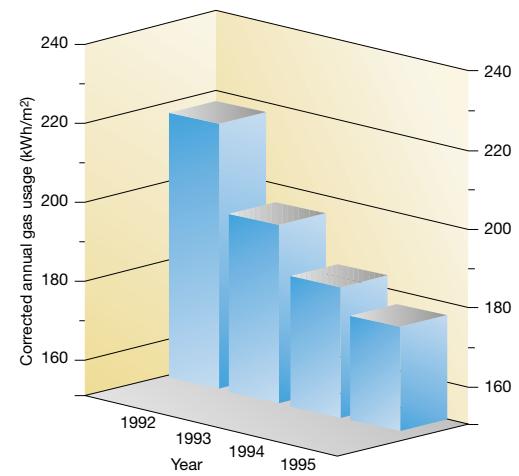


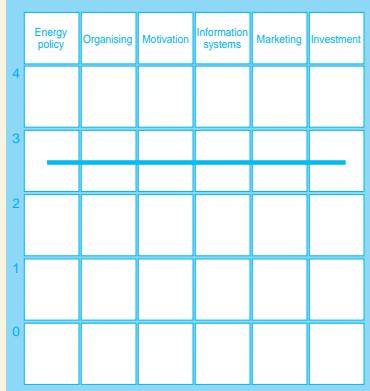
Figure 2 Average annual gas consumption

ENERGY MANAGEMENT MATRIX

M&T has also identified buildings where adjustments to the BEMS were needed to provide more effective control. In the Mathematics and Education building, for example, a drop in energy performance was traced to a failed stand-alone heating controller. The opportunity was taken to link the building to the BEMS with the result

that energy consumption fell by 48% from 250 to 130 kWh/m², saving £7000 per year.

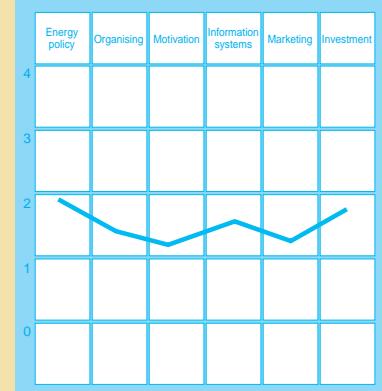
Rectifying control faults identified by M&T reduced the University's gas consumption between 1992 and 1995 from 216 to 179 kWh/m², a drop of 17%. This represents an annual saving of £63 000.



Example of a balanced matrix



Example of an unbalanced matrix



Average profile

ENERGY MANAGEMENT MATRIX

The energy management matrix is a simple diagnostic tool which is central to the DOE's Energy Efficiency Best Practice publications on the organisational aspects of energy management. DOE General Information Reports 12^[3] and 13^[4] describe in detail how the matrix should be used.

The matrix provides a quick, easy-to-use but effective method for organisations to identify and describe the current priority they attach to different aspects of energy management.

Each vertical column of the matrix deals with one of six key issues, namely energy policy; organising; motivation; information systems; marketing; and investment.

The ascending rows, from 0 to 4, represent increasingly sophisticated handling of these issues. The objective is to achieve a balanced improvement across the columns, and to reach as close to the top as possible.

Examples of a balanced and an unbalanced matrix are shown above (left and centre). Also shown above (right) is an average profile, calculated from the profiles drawn by over 1500 energy managers in a wide variety of public and private organisations throughout the UK.

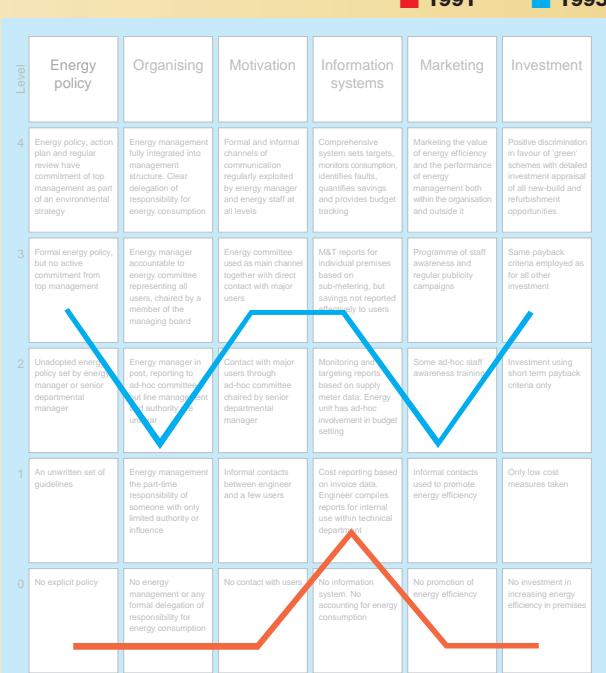


Figure 3 Feedback from the M&T system is reflected in Cardiff's position on the energy management matrix in 1995; particularly the improvement in the information systems category

HOST ORGANISATION



'The M&T system has proved invaluable in identifying which buildings to target for energy efficiency improvements and modifications to their control systems.

Building performance indicators have highlighted where to concentrate manpower and budgets to give the best returns, and regular monitoring has helped ensure that energy costs are kept down. It is also important for us to see that benefits are being achieved and maintained. Without this feedback, we could not properly manage our energy costs'.

Ian Lomer, Services Engineer, University of Wales, Cardiff.

UNIVERSITY OF WALES, CARDIFF

The University of Wales, Cardiff was formed in 1987 when University College Cardiff merged with UWIST, the University of Wales Institute of Science and Technology. There are currently 10 000 undergraduates and 3000 postgraduates. The annual energy bill is £2.1 million.

In 1991 overall responsibility for buildings management, including the energy budget, was given to a newly formed Estates Department. This centralisation of responsibility was a key factor in the successful launch of an energy efficiency strategy.

VERIFYING PERFORMANCE

VERIFYING PERFORMANCE

Another major use for M&T is to check the performance of energy saving measures. When lecture theatres were targeted for lighting improvements, three theatres were fitted with high frequency fluorescent lighting controlled by occupancy detectors. Monitoring of electricity consumption for three months both before and after installation showed a reduction in lighting costs of 40%. This feedback was used to justify extending the lighting improvements to a further 24 lecture theatres. Monitoring has also confirmed the cost-effectiveness of BEMS outstation control for heating and ventilation services. Both technologies can now be confidently specified for all new build and refurbishment projects.

FEEDBACK AND MOTIVATION

The monitoring system is a valuable source of information for providing feedback to staff.

Recognising that good housekeeping has a key role in controlling energy costs, the University is planning an energy awareness campaign in which the performances of individual buildings will be published monthly. Each notice board will also carry advice on good housekeeping measures, thereby providing both the means and the encouragement for all building users to help in reducing energy wastage. Monthly energy data will appear in league tables based on percentage variation from target. This measure will be used, rather than the target kWh/m² figures themselves, to assist comparison between buildings with high and low energy use.

The environmental benefits of energy savings will also be highlighted to raise environmental awareness among staff and students. Fuel savings achieved since M&T was introduced equate to a reduction in CO₂ emissions of 1350 tonnes a year.

CONCLUSIONS

In addition to saving £63 000 a year in gas costs, the M&T system has played a major part in containing electricity usage in spite of extra student numbers, increased IT loads and extended use of buildings. The environmental impact of M&T has also been significant.

REFERENCES

- [1] **Department of the Environment.** Energy efficiency in Buildings – Further and Higher Education Buildings. London, DOE, 1994.
- [2] **Higher Education Funding Council.** Energy Management Study in the Higher Education Sector National Report. London, HEFC, 1996.
- [3] **Department of the Environment.** General Information Report 12. Organisational aspects of energy management (GIR12). London, DOE, 1993.
- [4] **Department of the Environment.** General Information Report 13. Reviewing energy management (GIR 13). London, DOE, 1993.



The Government's Energy Efficiency Best Practice programme provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice programme are shown opposite.

Visit the website at www.energy-efficiency.gov.uk
Call the Environment and Energy Helpline on **0800 585794**

For further specific information on:

Buildings-related projects contact:

Enquiries Bureau

BRECSU

BRE

Garston, Watford WD25 9XX

Tel 01923 664258

Fax 01923 664787

E-mail brecsuenq@bre.co.uk

Industrial projects contact:

Energy Efficiency Enquiries Bureau

ETSU

Harwell, Oxfordshire

OX11 0RA

Tel 01235 436747

Fax 01235 433066

E-mail etsuenq@aeat.co.uk

Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy-efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R&D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be fully established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Introduction to Energy Efficiency: helps new energy managers understand the use and costs of heating, lighting, etc.